NON-PUBLIC?: N
ACCESSION #: 9105150346
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Millstone Nuclear Power Station Unit 1 PAGE: 1 OF 12

DOCKET NUMBER: 05000245

TITLE: Manual Reactor Trip Due to Loss of Cooling
EVENT DATE: 10/04/90 LER #: 90-016-01 REPORT DATE:

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: N POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)
50.73(a)(2)(v)

LICENSEE CONTACT FOR THIS LER:
NAME: Charles Wargo, Ext. 4374 TELEPHONE: (203) 447-1791

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: Yes EXPECTED SUBMISSION DATE: 05/31/91

ABSTRACT:

On October 4, 1990, at 1849, while reducing power during storm conditions, a manual reactor trip from 45% power (530 degrees F, 1030 psi) was initiated because of degraded conditions in the Service Water and Circulating Water supplies. Seaweed buildup on the intake structure traveling screens exceeded the Screen Wash system removal capability. Debris was carried over the Traveling Screen head shaft. Operators stopped the traveling screen rotation to conduct cleaning. Circulating Water Pumps were not tripped in accordance with the Operating Procedure 323. Three of five traveling water screens incurred damage to the outer baskets because of high differential pressure. Service Water pressure decreased due to pump cavitation and Self Cleaning Strainer fouling. A manual scram was initiated when low service water pressures were noted combined with increasing containment temperature, pressure and decreasing condenser vacuum. The containment temperature/pressure increase was the consequence of degraded Reactor Building Closed Cooling Water heat exchanger performance. The Service Water system recovered once the pumps regained adequate submergence. Cold shutdown was achieved with the remaining intact Traveling Screens, Circulating Water Pumps, and Service Water Pumps. The Service Water Strainer Bypass valve provided additional sea water cooling reliability. A second Reactor Protection system trip due to low reactor vessel level was experience during recovery from the initial event.

END OF ABSTRACT

I. Description of Event

On October 4, 1990 at 1849, while reducing power during degraded weather conditions, a manual reactor trip from 45% (530 degrees F, 1030 psi) power was initiated when the Operating Shift noted low service water pressures combined with increasing containment temperatures, pressures and decreasing condenser vacuum. High winds and heavy seas had been building through the afternoon of October 4. At 1330 Off Normal Procedure 514 "Natural Occurrences", was entered when winds exceeded 30 mph. The Service Water Strainer was placed in the continuous blowdown mode. All screens were selected for continuous slow rotation. The following chronology describes the sequence of events. Refer to the attached figures for additional information.

Note: Some times reported herein are approximations based on the series of events, others have been gathered from security and process computer logs. The difference between these two computer timers is estimated to be on the order of 1 - 2 minutes.

1800 Alarms indicated one traveling water screen had greater than a 10 inch differential pressure. Four to five feet of debris had collected in front of the screen.

1810 Duty Officer was notified. Maintenance personnel were contacted to remove the Screen Wash Sluiceway. The sluiceway provides a pathway for the live return of fish and crustaceans to the sea after being sprayed clear of the traveling water screens.

1813 A Control Operator and Plant Equipment Operator arrive at the Intake Structure and commence manually cleaning 'E' traveling water screen, however differential pressure was increasing on other screens.

1825 An additional Plant Equipment Operator arrived at the screen house.

1830 Plant Equipment Operators clear 'E' traveling water screen and decide to manually clean 'A' traveling water screen. All screens were stopped by securing the Screen Wash Pumps to accomplish this task.

1835 The Operating Shift noted all screen differential pressures are off scale high (greater than 60"). A rapid power reduction was initiated. Operators at the Intake Structure were instructed to restart all screens.

1836 Condenser Vacuum alarmed at 27.3 inches of Hg.

1837 Service Water pressure was 9.6 psig.

Note: This data point was taken from Computer logs after the event. It is provided for general interest and to support the analysis provided later in the discussion.

1838 In response to off scale high traveling screen differential pressure the Shift Supervisor tripped 'A' and 'D' Circulating Water Pumps. Associated screens 'A' and 'D' began to operate. ('B','C','E' traveling screens outer baskets were breached by the accumulated debris and associated differential pressure and failed to rotate.)

1839 The Service Water Strainer high differential pressure alarm was received in the Control Room.

1839-1847 Control Operators stopped and restarted Circulating Water Pumps in an effort to reduce differential pressure and seaweed load on traveling screens.

I. Description of Event (Continued)

1841 Condenser vacuum was 25.5 inches of Hg.
Service Water pressure was 1.6 psig.
Reactor Power was 70%

Note: These data points were taken from Computer logs after the event. It is provided for general interest and to support the analysis provided later in the discussion.

1845 Reactor power was 50% and decreasing. Circulating pump and traveling screen conditions were not improving,'B','C','E' Traveling screen motor breakers were tripped open on a fault condition, Circulating Water pump seal water pressures and flows were low.

1847 A high drywell pressure alarm was received. The Control Operator began venting the drywell through the Standby Gas Treatment System.

1848 Operating Shift noted Service Water pressure at 7 psig, 'C' Service Water pump was started to improve header pressure.

1849 A manual reactor scram was initiated.
Drywell Pressure - 1.42 psig increasing
(1.1 psig normal)

Drywell Bulk Temperature - 142 degrees F increasing
(130 degrees F normal)

Reactor Building Closed Cooling Water
Heat Exchanger discharge - 110 degrees F increasing
(72 degrees F normal)

Note: These data points were taken from Computer logs after the event. It is provided for general interest and to support the analysis provided later in the discussion.

1850 Group 2 and Group 3 containment isolations actuated at 8 inches Narrow Range Yarway Reactor Water Level signal (normal level response following void collapse).

1854 Control Operator reset the Reactor Scram.

1901 Reactor Water Clean Up System tripped. (Reducing load on Reactor Building Closed Cooling Water System.)

1902 Drywell pressure peaked at approximately 1.48 psig.

Note: This data point was taken from Computer logs after the event. It is provided for general interest and to support the analysis provided later in the discussion.

1904 Service Water pressure is approximately 14.5 psi.

1907 Reactor Water Low level alarm was received in the Control Room. (20 inches Narrow Range Yarway reactor water level)

1909 PEO throttled open the Service Water Strainer Bypass Valve (1-SW-19).

I. Description of Event (Continued)

1909 Reactor Protection System trip signal was received on Low Reactor Water Level.
Group 2 and Group 3 containment isolations actuated at 8 inches Narrow Range Yarway Reactor Water level.
Control Operator restored level by starting a Reactor Feed Pump.

1911 Control Operator reset the Reactor Scram.

1912 Drywell Bulk Temperature peaked at 155 degrees F.
Senior Control Operator entered EOP 580 and verified that required actions had been taken.

A cooldown was initiated with the intact 'A' and 'D' Traveling Screens and associated Circulating Water Pumps using the Main Condenser. Service Water pressure recovered during the period from 1841 through 1904. Operation of the Strainer Bypass Valve (1-SW-19) further ensured reliable sea water cooling was available. The plant achieved Cold Shutdown on October 5, 1990 at 1835 hrs.

II. Cause of Event

The root cause of the Reactor Protection System (RPS) trip was that the Traveling Screen fouling rate exceeded the Screen Wash System Cleaning capability during severely degraded weather conditions. On shore winds, high seas and an incoming tide combined to create a condition where the debris removal equipment (traveling screens, screen wash system, debris sluiceways) was unable to handle the debris volume.

The root cause of extensive screen damage, Service Water pump cavitation and induction of debris into the Service Water strainer was failure to follow Operating Procedure 323 which required a manual trip of the Circulating Water Pumps when differential pressure reached 30 inches. The lowered level put excessive strain on the traveling water screen outer baskets and exposed Service Water Pumps to less than acceptable submergence. Buoyant debris in the upper water column was then ingested by the pump.

Contributing Causes: Plant Equipment Operators did not coordinate cleaning of the 'A' traveling screen with the Control Room. All screens were stopped by securing the Screen Wash Pumps to accomplish this task. Therefore, Control Room Operators were not confident of the off scale screen differential pressure indication. Control Operators elected to trip only 'A' and 'D' Circulating Water Pumps.

The root cause for the second Reactor Protection System Trip (Low Reactor Water Level) was that establishing a valve lineup which maintained the Feedwater Coolant Injection System operable impacted timely manually controlled injection of feedwater when level was less than 30 inches on the Narrow Range GEMAC instruments.

Contributing Cause: The published low water level scram setpoint is 8 inches Narrow Range Yarway Reactor Water level, however the actual low water level scram setpoint can conservatively set as high as 12 inches indicated Narrow Range Yarway Reactor Water level. The operator actions were influenced by his belief that the low water level RPS trip would occur at 8 inches.

III. Analysis of Event

At 1800 on October 4, 1990 the Traveling Screen fouling rate exceeded the Screen Wash System Cleaning Rate during severely degraded weather conditions. On shore winds, high seas and an incoming tide combined to create a condition where the debris removal equipment (traveling screens, screen wash system, debris sluiceways) were unable to handle the debris volume. The traveling screens were experiencing debris carryover. Plant Equipment Operators engaged in manual cleaning of the traveling water screens elected to stop all screens to provide access to the interior of the screen housings for manual debris removal. At this time the Operating Shift had not been informed of the new screen status. As debris continued to collect the traveling screen differential pressure rapidly increased. Control room personnel observed all five traveling screen differential pressure instruments off scale high. A rapid decrease in reactor power was initiated. Control Room personnel questioned the validity of the off scale differential pressure and did not elect to trip all Circulating Water Pumps per Operating Procedure 323. 'A' and 'D' Circulating Water Pumps were stopped at 1838 hrs, relieving the strain on the associated screens. 'B' and 'C' Circulating Water Pumps continued to pump, lowering level in the bays and increasing differential pressure on 'B' and 'C' screen as well as the interconnected 'E' screen. The level decrease cavitated the operating Service Water Pumps. 'B','C' and 'E' screen outer baskets and support structure yielded to the strain, but the inner baskets remained intact. The screen differential pressure was now shared by the inner and outer baskets. Following failure of the outer row of screen baskets, the inner baskets continued to provide protection for the intake structure pumps. The continuous belt arrangements provides two barriers to the ingestion of debris into the intake structure (See Figure 4). Cleaning of heat exchangers throughout the event was not required, inspections yielded minimal debris. After the conclusion of the event debris inside the Intake Structure was not significant, supporting indicating that the inner screen baskets were effective barriers. At approximately 1839 'B','C' and 'E' bays of the Intake Structure reflooded, ending the cavitation but, introducing debris to the Service Water pump suctions. It is speculated that while the water level was at the pumps suctions the Service Water Strainer was fouled by the buoyant marine plant Codium which was not immediately expelled by the strainer blowdown subsystem.

Codium is not native to North America, introduced around 1955 it is expanding its domain in this area. It experiences high productivity during the late summer months. Codium is buoyant, free floating in the water column, when not attached to its holdfast. The cross section of this marine plant closely matched the pore diameter of the Service Water Strainer, plugging a high percentage of the strainer basket was evident when the strainer was disassembled for inspection.

The low Service Water Pressure reduced Reactor Building Closed Cooling Water Heat Exchanger capacity. These heat exchangers are located at the 42'6" elevation of the Reactor Building. Drywell Temperature and Pressure began to increase and a high Drywell pressure alarm was received in the Control Room. The drywell was vented through the Standby Gas Treatment System. During the evaluation of the containment pressure increase, Service Water pressure was observed to be 7 psig in the Control Room. An additional service water pump was started to increase header pressure. A Manual Scram was initiated at 1849 hrs. Service Water system pressure continued to improve while the strainer operated in continuous blowdown. An indicated pressure of 14.5 psi is required to reach the elevation of the Reactor Building Closed Cooling Water Heat Exchangers this was first achieved at 1904 hours. The increasing Reactor Building Closed Cooling Water temperature trend also began to turn around in this time frame in part aided by a Cleanup System trip at 1901 hrs. Operation of the Service Water Strainer Bypass Valve at 1909 provided additional assurance that effective sea water cooling was available.

III. Analysis of Event (Continued)

If all circulating water pumps had been tripped on increasing differential pressure, traveling screens 'B','C' and 'E' would not have been breached. Service Water Strainer fouling and the associated containment temperature/pressure increases would not have occurred, however a Turbine trip and associated Reactor Scram would still have occurred. The decision to trip Circulating Water Pumps was delayed because the Control Room personnel were unaware that all traveling water screens had been stopped for cleaning. This complicated the decision while the legitimacy of the simultaneous off scale differential pressure indications were considered. Delays in tripping 'B' and 'C' Circulating Water pumps eventually threatened the operation of the Service Water system. Discharge pressure degraded on the operating service water pumps as the level decreased in the Intake Structure. At 1836 hours Service Water Pumps cavitated. It is assumed that Emergency Service Water (ESW) Pumps would also cavitate if required to operate at this time. It is also postulated that buoyant debris which previously carried over the traveling screen was concentrated at the upper layer of the water column. This debris caused the high Service Water Strainer differential pressure when level was restored following failure of the outer row of traveling screen baskets at 1839 hours. Trends of Service Water pressure indicate Service Water System performance continued to improve without operator intervention as fouling was cleared by the strainer blowdown subsystem. If Emergency Service Water had been called upon to function following reflood, it would have performed, although this can not be confirmed. We believe the ESW system did not lose the ability to fufill it's safety function because the period when submergence was not adequate was well within the time frame analytically assumed for operator action and debris was not a considerable problem following reflood the 'E' bay. (Reference E.J. Mroczka letter to U.S. Nuclear Regulatory Commission, "Intake Structure Event," dated May 3, 1991.)

Throttling open of the Service Water bypass valve at 1909 hours had minimal impact on system pressure, but provided greater assurance that reliable sea water cooling was available. Only minor fouling of the Closed Cooling Water Heat Exchangers was experienced when disassembly/inspections were conducted.

This event had the potential to result in degradation of the Service Water and Emergency Service Water to a condition where available flowrates from those systems could have been ineffective. The Service Water System provides cooling to the Turbine and Reactor Building Closed Cooling Water Heat Exchangers and to the Diesel Generator Heat Exchangers. The Emergency Service Water System provides a long term source of cooling water to remove heat from the Suppression Pool during both LOCA and non-LOCA conditions (refer to the attached system diagrams). Millstone One Off Normal Procedures 524D "Loss of Service Water," and 525G "Degraded Fire in the Intake Structure," provide operator guidance for more severe events of this type.

A loss of Service Water & Emergency Service Water is an event considered to be outside the design basis for Millstone One. Postulating the concurrent occurrence of a LOCA in addition to the loss of Service Water/Emergency Service Water event is not required from a design basis perspective.

The following systems remained completely available throughout the event to mitigate the consequen
es of a complete loss of Service
Water and Emergency Service Water, were it to have occurred.

- Gas Turbine

- One train of Low Pressure Coolant Injection and Core Spray

- Automatic Pressure Relief or manual Safety/Relief Valve operation to depressurize the Reactor

- Atmosphere Control and Standby Gas Treatment for venting Containment

- Isolation Condenser

- One Control Rod Drive Pump in the self cooling mode

III. Analysis of Event (Continued)

Operation of these systems are sufficient to ensure that adequate core cooling and vessel level make up can be maintained without the use of Feedwater or Feedwater Coolant Injection, while an additional random single failure is postulated. (Reference E.J. Mroczka letter to U.S. Nuclear Regulatory Commission, "Intake Structure Event," dated May 3, 1991.)

A second Reactor Protection System (RPS) trip on low reactor water level was received at 1909 hrs on October 4, 1990. This Emergency Safety Feature actuation was not separately reported on October 4, 1990 as it was considered part of the overall event. It is discussed here in relation to this event as this RPS actuation was an integral part of the recovery from the transient.

Following a scram the level control system responds to reduced level from void collapse, and the Feedwater Regulation Valves open. This coincides with decreased steam production post-scram. The ensuing overshoot of the level control system must be managed by the Control Operator. Control Operators are trained to sequentially secure Reactor Feed Pumps to terminate the increasing level trend. From this point on, pressure control and decay heat removal via the Main Turbine Bypass Valves and Main Condenser lowered reactor water level while make up was limited to 50 gpm from the Control Rod Drive cooling water flow. The Control Operator upon receiving the low level alarm proceeded to line up the Feedwater System, closing one Feedwater Regulation Isolation Valve and selecting the other Feedwater Regulation Valve to manually control the rate of injection per the Operating Procedure 316 "Feedwater System." While waiting for the Feedwater Regulation Isolation Valve to close, the RPS trip signal was received. The Technical Specification Low Reactor Water Level RPS trip is 8 inches. This setpoint can be conservatively set as high as 12 inches indicated. As left setpoints for this RPS trip would have resulted in a scram at 10 inches reactor water level. Instrument drift between calibrations is on the order of one-half inch and no greater than 1 inch during typical calibration intervals. A Reactor Feed pump was started and level was immediately restored and the RPS trip was reset. The safety significance of this event is minimal in that the Control Operator was standing by in control of reactor water level when the RPS trip was received and all Emergency Core Cooling systems were available to respond to a more severe level transient.

This event is reported in accordance with 10CFR50.73(a)(2)(iv), any event or condition that results in manual or automatic actuation of an Engineered Safety Feature, and 10CFR50.73(a)(2)(v), any event that alone could have prevented the fulfillment of the safety function of structures or systems that are needed to remove residual heat or mitigate the consequences of an accident. Although this event was promptly reported pursuant to 10CFR50.72 (b) (2) (i), based upon recent analysis of the event an Emergency Action Plan 'Unusual Event' report should have been made.

IV. Corrective Action

The Circulating Water Pump trip logic was modified to reinstate a 30 inch screen differential pressure trip. Operating Procedure 323 "Circulating Water System", was revised to instruct Control Operators to verify Circulating Water Pump trips at 30 inch screen differential pressure.

Off Normal Procedure 514A, "Natural Occurrences" will be revised to terminate Screen Wash debris/fish return capability and begin intercepting debris cleaned from the Traveling Screens at sustained winds of greater than or equal to 30 mph. This is to minimize the debris load in front of the Intake Structure during degraded weather conditions.

Additional guidance has been communicated to the Operations staff should winds approach 30 mph., including:

a) Request an updated weather report.

b) Place service water strainer in manual blowdown.

c) Increase watch frequency at the intake structure.

d) Remove sluiceway and put trash baskets in place.

e) Make arrangements for Maintenance support of trash basket and heat exchanger cleaning.

f) Make arrangements for additional Plant Equipment Operator (PEO) support.

g) As directed in OP 514A - Natural Occurrences, if loss of Circulating Water Pumps is imminent, quickly lower power to minimum speed of Recirculation Pumps. A design review has been commissioned to evaluate Traveling Screen performance in severe weather with respect to debris removal methods and equipment.

The Operations Manager will review plant operating philosophy with the Operations Department personnel on the following subjects. This activity is in progress and will be completed by 12/15/90.

a) The operators use and belief of instrumentation with appropriate confirmation.

b) The operators use of effective communication during normal and abnormal conditions with emphasis on informing the Control Room when changing equipment status.

c) The importance of conservative decision making. This review will focus on strengthening existing philosophy and assuring the Operations staff that this philosophy is supported by Station Management.

The Operator Training Department has been requested to evaluate this event and provide an assessment from a training perspective.

A review of past Millstone One design changes will be conducted to ensure that any protective trip functions previously removed have no significant impact on plant safety or reliability.

A review of Operating Procedure 316 "Feedwater System" will be conducted. This review will evaluate reactor water level response post-scram and provide the operator actions required to control level more efficiently.

V. Additional Information

The following attachment and information is being provided to identify the system and components affected by the event.

EIIS Codes

Systems Components

Circulating Water System - KE Pumps - P

Traveling Water Screens - SCN

Condenser - COND

Emergency/Service
Water Systems - BI Service Water Strainer - STR

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Figure 1 "Intake Structure" omitted.

TEXT PAGE 10 OF 12

Figure 2 "Emergency Service Water System" omitted.

TEXT PAGE 11 OF 12

Figure 3 "Service Water System" omitted.

TEXT PAGE 12 OF 12

Figure 4 "Traveling Water Screens" omitted.

ATTACHMENT 1 TO 9105150346 PAGE 1 OF 1

NORTHEAST UTILITIES
NU The Connecticut Light And Power Company
Western Massachusetts Electric Company
Holyoke Water Power Company
Northeast Utilities Service Company
Northeast Nuclear Energy Company

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10CFR50.73(a)(2)(iv)&(v)
MP-91-368
May 3, 1991

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Reference: Facility Operating License No. DPR-21
Docket No. 50-245
Licensee Event Report 90-016-01

Gentlemen:

This letter forwards update to Licensee Event Report 90-0160-01 submitted pursuant to 10CFR50.73(a)(2)(iv) and 10CFR50.73(a)(2)(v).

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

FOR: Stephen E. Scace
Director, Mllstone Station

BY: Carl H. Clement
Millstone Unit 3 Director

SES/CW:dlr

Attachment: LER 90-016-01

cc: T. T. Martin, Region I Administrator
W. J. Raymond, Senior Resident Inspector, Millstone Unit Nos. 1, 2
and 3
D. H. Jaffe, NRC Project Manager, Millstone Unit No. 1 and 3

*** END OF DOCUMENT ***
